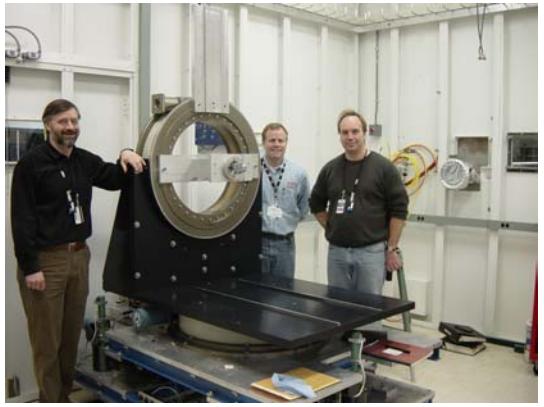
In-Situ X-ray Studies of Surface Structure During Plasma Processing

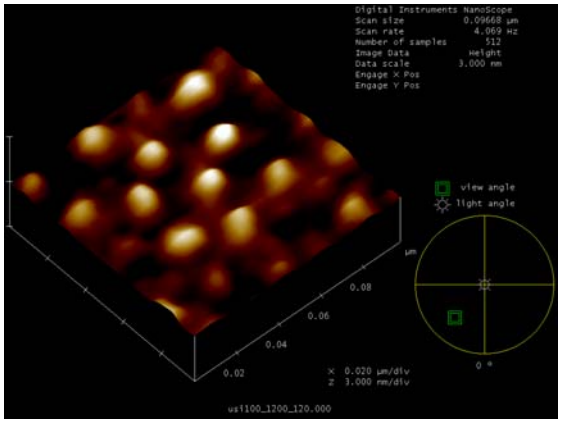
Karl Ludwig, Boston University

DMR-0208011

We have developed a specialized system that allows us to use intense x-rays from the National Synchrotron Light Source (NSLS) to study how the atoms in materials arrange themselves during ion bombardment and plasma processing. These are technologically important processes widely used to etch and passivate semiconductor surfaces. In state-of-the-art etch processing the delineation of device features is performed on the nanometer-scale and processing must stop on the atomic scale. Synchrotron-based x-ray scattering can give us fundamental atomic-level insight into the processes (e.g. surface diffusion) occurring during surface ion and plasma exposure. To optimize our impact and capabilities, we are collaborating with Dr. C. Eddy of the Naval Research Laboratory (NRL) and Prof. R. Headrick of the University of Vermont (UVM).



Above: Ludwig (BU), Eddy (NRL) and Headrick (UVM) with the base diffractometer installed at the NSLS. Below: Atomic Force Microscope image of a silicon surface after bombardment by ions. A local order of hills created by the ion bombardment is seen.



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Education and Outreach:

Four graduate (Ahmet Özcan, Justin Hotchkiss, Gözde Ozaydin, Yiyi Wang) and two undergraduate students (Marta Szpilowska and Michael D'Emic) have been contributing to this project. Marta helped assemble the ultra-high vacuum processing chamber and is now learning x-ray reflectivity; Michael used computer simulations to better understand the damage to silicon surfaces caused by low-energy ions. Students have an excellent opportunity to learn about important materials technologies and to interact with scientists beyond their home academic institution.

During Summer 2002, we introduced two students in the Boston University High School Honors Summer Research Internship Program (Scott Schwitz and Erica Chan) to materials research. They examined ion-bombarded surfaces with atomic-force microscopy.

Above: Clockwise from bottom left, Szpilowska, Ozaydin and Ozcan with the processing chamber. Below: Ludwig with Chan and Schwitz.